

days, values were below 40 k. p. h. Indications that the southwesterly air stream was weak over southern Indochina and Thailand were shown by the scattered reports received from these regions.

Typhoon, October 22–November 2, 1941.—As well as can be determined from available data, this typhoon seems to have formed far to the southeast or south-southeast of Guam. On October 22, a definite center, quite intense, seemed to be located about 300 miles south-southeast of Guam, and its movement was in a north-northwesterly direction. From October 23 to 25, this typhoon moved northerly along a course about 120 miles east of Guam. The next 3 days the center seemed to be close to and east of the northern Mariana Islands, stationary perhaps, or moving slowly in various directions. October 28 to 31 it moved west-northwest to the ocean regions about 300 miles southwest of the Bonin Islands. It either disappeared over those regions or moved about 500 miles to the east as a low pressure area (October 31 to November 2), after which no trace of the storm could be found.

The upper winds over Guam from October 17 onward were from the northeast and east quadrants, the velocities never exceeding 47 k. p. h., and mostly between 5 and 30 k. p. h. On October 21, the winds were backing to the north-northeast, velocities being less than 40 k. p. h. On October 22 and the two following days, the directions were from the north-northwest and north, with velocities ranging from 15 to 67 k. p. h. October 25 and the following days, Guam was under the influence of air streams from the west and southwest quadrants, with velocities less than 40 k. p. h. Stations over the Philippines were reporting directions from the northeast, east, and south-east quadrants during these days, with no evidence that the southwest monsoon air stream was present over the Archipelago.

After October 19, no ships' observations were on hand. The above account of the origin and course of the typhoon, especially after October 24, may have to be altered when observations from ships become available later.

RIVER STAGES AND FLOODS

By BENNETT SWENSON

The month of October was marked by continued drought conditions in the East and by floods in a belt extending from New Mexico and Texas northeastward to Illinois and Wisconsin. The floods were especially severe in the three states, Kansas, Oklahoma, and Missouri, and some adjacent areas, with unusually high stages in the Kansas, Neosho, Verdigris, Cimarron, Washita, North Canadian, Canadian, and Arkansas Rivers and their tributaries in Kansas, Oklahoma, and Arkansas and in the Osage River in Missouri. The floods were the highest observed in parts of the Smoky Hill, Osage, Verdigris, Neosho, and North Canadian Rivers, and the Arkansas River was rising to unprecedented heights in the vicinity of Fort Smith at the close of the month. The resulting property damage was extensive.

Atlantic Slope and East Gulf of Mexico drainage.—River stages remained unusually low with only a slight improvement in a few areas. Precipitation since the first of the year in all of the states in the drainage was well below normal. In the Middle Atlantic States the precipitation for the two months, September and October, has been especially scanty; New Jersey, Maryland, and Virginia had the least rainfall of record for these 2 months.

Upper Mississippi Basin and St. Lawrence drainage.—Precipitation was well above normal in most of this area and river stages were high. Flood stages were reached or exceeded, however, only in the Wisconsin, Rock, Des Moines and Illinois Rivers, and in the Mississippi proper from Quincy, Ill., to Grafton, Ill., during the month, with no appreciable damage.

The Wisconsin River rose to slightly above flood stage on October 8 and again on the 28th at Knowlton, Wis.

Heavy rains in the lower Des Moines River Basin, on the 8th, together with rises in the river from heavy rains upstream several days previously, resulted in some overflow in the lower reaches. The river reached 15.8 feet (0.8 foot above flood stage) at Eddyville, Iowa, on the 9th.

The Rock River showed two rises during the month, exceeding flood stage by 0.3 and 0.6 foot, respectively, on the 11th and the 25th at Moline, Ill. The Illinois River similarly experienced two rises during approximately the same periods to moderately high flood stages.

Heavy discharge from the tributaries of the Mississippi River resulted in slight overflows in the main channel from Quincy to Grafton, Ill. These high stages, together with the flood waters from the Missouri River, were expected to cause some flooding in the Mississippi below the Missouri junction, but failed to materialize due to the low stage in the Ohio River which permitted a rapid run-off in the Mississippi.

Ohio River Basin.—Stages remained unusually low generally throughout the Basin. The mean stage at Cairo, Ill., 22.5 feet, was high as compared to the October normal of 11.1 feet, but represented the stage of the Mississippi rather than the Ohio River.

Missouri and Arkansas River Basins.—Much of the month was characterized by the presence of a large anticyclone over the southeastern United States, producing a strong inflow of moist tropical air over the southern and central plains states. Frequent outbreaks of cold air resulted in heavy downpours over Iowa, Kansas, Oklahoma, Missouri, and parts of Arkansas and Texas. It was the wettest October of record in Kansas, Oklahoma and Missouri, with previous high records exceeded by large amounts in some cases; Missouri had 43 percent more rainfall than for any previous October and Kansas 50 percent more than heretofore recorded.

Floods have been the rule, rather than the exception, in the Kansas and Neosho River Basins this year from April to October, as is shown in table 1. Flood stage has been reached or exceeded in these basins every month during this period except in May. The months of particularly severe flooding were June, September, and October. The highest stages of record have been established at a number of points during the 7-month period.

The official in charge, Topeka, Kans., reports as follows on the floods in the Topeka district (including the Kansas River Basin except the Republican River, and the Osage and Neosho Rivers in Kansas):

Overflows occurred in every river of the district during October 1941 and were especially severe along the Smoky Hill River, the upper reaches of the Neosho River, and the headwaters of the Cottonwood River. The Kansas River, which had never before been known to overflow later in the year than July, staged two distinct overflows from Manhattan to below Lawrence, Kans., during the month.

Three cities in the district—Salina, Council Grove, and Marion, Kans.—suffered very serious overflows, which in each case covered much of their areas. At Salina, where the Smoky Hill reached the highest stage since 1903, 700 homes were damaged and the flood loss was placed at \$100,000. At Council Grove, where there was a flash flood due to torrential rains in the headwaters of the Neosho

River, the business section was flooded and, while no estimate of the damage in the town itself was available, the loss in the county, Morris County, was placed at \$390,000. At Marion, where the business section and much of the residential section was inundated, the loss was severe, the damage for Marion County being placed at \$593,000, much of which, of course, occurred in Marion itself.

Parts of the business and residential sections of Abilene were flooded, with damage to homes and business properties estimated at \$50,000.

Total losses from these overflows in the district during the month was estimated at \$6,523,150. The greater part of this loss was to matured crops, totaling, according to the estimates, \$3,082,400. Damage to bridges and highways was estimated at \$1,019,500, and to growing crops, \$1,725,100.

The highest water reported in the district was along the Smoky Hill River, from some distance above Lindsborg, Kans., to its junction with the Republican River at Junction City, Kans. At Lindsborg the crest stage was 32.4 feet at midnight on October 20. This was 11.4 feet above bankful and has been exceeded only three times—in June 1938, in 1903, and in 1895. At Salina the crest was 24.25 feet at 2:10 p. m. of October 20. This was 4.25 feet above bankful and has been exceeded only once, in 1903, when the crest was 24.64 feet. At Enterprise the crest was 30.1 feet, 4.1 feet above bankful, at 7 a. m. of October 21, which has been exceeded only by the high water of 1903, the crest of which, from the best available sources, was 32.0 feet.

The Solomon River overflowed moderately twice during the month. The highest stage reached during the month was 26.3 feet, 8.3 feet above bankful, at Beloit, Kans., on the 10th. At Niles, Kans., the highest crest was 27.9 feet, 3.9 feet above bankful, on the 14th.

Both the Big Blue and Little Blue Rivers staged slight overflows, generally not more than one to four feet above bankful.

The Kansas River overflowed once at Ogden, Kans., where the crest stage was 20.7 feet, 2.7 feet above bankful, on the 22d. At Manhattan, Kans., it overflowed twice, with a crest of 21.2 feet, 4.2 feet above bankful, on the 10th, and of 21.8 feet, 4.8 feet above bankful, on the 23d. At Wamego, Kans., the first crest was 18.4 feet, 2.4 feet above bankful, on the 10th, and the second, 16.9 feet on the 23d. At Topeka the first crest was 24.6 feet, 3.6 feet above bankful, on the 10th, and the second crest was 24.3 feet on the 21st. At Lecompton, Kans., the first crest was 21.6, 4.6 feet above bankful, on the 11th, and the second crest, 20.8 feet on the 21st. At Lawrence, Kans., the overflows were slight. The first crest was 21.3 feet, 3.3 feet above bankful, on the 11th, and the second crest was 20.2 feet on the 21st.

The upper reaches of the Cottonwood River overflowed badly, but at Emporia, Kans., the overflow was only moderate. The first crest at that place was 23.35 feet, 3.35 feet above bankful, on the 15th, and the second crest was 25.0 feet on the 22d.

Damage along the Neosho River in Kansas, especially the lower reaches of the river, was prolonged and severe and generally occurred in two rather distinct floods—one near the middle of the month and one beginning about a week later. The highest point reached at Neosho Rapids was 28.1 feet, 6.1 feet above bankful, on the 21st. On the 15th Neosho Rapids reached a crest of 26.3 feet. At Le Roy a crest of 24.7 feet, 1.7 feet above bankful, was reached on the 17th, and a second crest of 26.5 feet occurred on the 23d. At Iola a crest of 16.3 feet, 1.3 feet above bankful, occurred on the 18th, and in the second overflow a crest of 20.0 feet was reached on the 26th. At Chanute there were two moderate overflows which crested on the 5th and 19th. These were followed by a crest of 27.2 feet, 7.2 feet above bankful, on the 28th. At Parsons there were three distinct crests—on the 6th, 17th, and 31st. The highest of these was on the 31st and was 27.4 feet, 5.4 feet above bankful. At that place the river was over its banks 14 days during the month. At Oswego the first crest was 23.65 feet, 6.65 feet above flood stage, on the 6th, and the second crest was 25.0 feet on the 31st, which is within 0.4 foot of the highest stage known at that place. The river at Oswego was over its banks on 22 days of the month and did not finally return to its banks until the 6th of the following November.

Two moderate overflows occurred along the Marais des Cygnes (Osage) River in Kansas. At Quenemo the highest crest reached was 35.4 feet, 5.4 feet above bankful, on the 22d. At La Cygne the crest was 28.4 feet, 3.4 feet above bankful, on the 25th. At Trading Post the highest point reached by the river was 26.2 feet, 2.2 feet above bankful on the 27th. At the latter place the river was over its banks on 19 days during the month.

Slight overflows occurred in the Republican River on October 9–10, but no appreciable damage resulted.

The Osage River, which was in moderate flood in the upper reaches during much of the month, reached record breaking stages in the lower portion, below Bagnell Dam,

where exceptionally heavy rains occurred on October 5, At St. Thomas, Mo., a high stage of 34.5 feet was reached on the 7th, nearly 2 feet above the previous highest stage in 1935. A rise of 12 feet in 24 hours occurred in the Missouri River at Hermann, Mo., below its junction with the Osage. Such a rapid rise has occurred only three times at that place in the last 69 years.

The Grand River at Chillicothe, Mo., and below was in light flood; very little damage was experienced except in the extreme lower reach from backwater of the Missouri River.

Heavy damage was sustained in Jefferson County, Kans., on October 21–22, by overflow in the Big Stranger Creek, especially near its mouth. Total damage has been estimated at \$600,000.

A disastrous overflow occurred during the month in Cow Creek which empties into the Arkansas River at Hutchinson, Kans. This was caused by heavy rains which began in the upper watersheds of Cow Creek and the Little Arkansas on October 19, and continued at intervals until the 22d; the rains at the beginning of the period were especially heavy.

Upper Cow Creek began to flood immediately after the beginning of the rain on the 19th, the flood crest reaching Hutchinson on the 23d. That city, which had suffered from an even more disastrous flood in June 1929, when more than \$2,000,000 damage occurred, was better prepared in this case, the Reno County engineer's office having set up a warning service after the flood of 1929. The damage from the recent flood in Hutchinson and vicinity has been estimated at \$595,000, of which \$144,800 was to farming interests and to roads and bridges outside of the city, \$250,000 to private property in Hutchinson, and \$200,200 to the city of Hutchinson.

Only a slight overflow occurred in the upper portion of the Little Arkansas, and the highest stage in the Arkansas River at Hutchinson during the rise in Cow Creek was 5.5 feet (0.5 foot below flood stage).

Extensive overflows occurred in the North and South Canadian Rivers, and in the Verdigris and Cimarron Rivers. The Verdigris River reached a stage of 42.0 feet at Sageeyah, Okla., on October 7, 7 feet above flood stage and 1.6 feet above the previous high stage of record in April 1929.

In the North Canadian River, the flooding was severe in the Yukon-Oklahoma City area; at Yukon, Okla., a stage of 17.0 feet was reached on October 28 and at Oklahoma City 14.7 feet was recorded on the 30th. These stages were the highest since the establishment of the gages at the two points.

The Arkansas River proper began flooding during the first week in October below the Kansas-Oklahoma line, followed by another pronounced rise near the middle of the month. The frequent rains during the month culminated on the 29–30th, when exceptionally heavy rains occurred over the lower Neosho, the North Canadian and the Arkansas River in Oklahoma. The Arkansas River rose to unprecedented heights in the vicinity of Fort Smith, reaching a stage of 37.3 feet on November 2–3. This stage exceeded the high stage of 36.7 feet at that place which occurred in April 1927.

White River Basin.—Heavy rains in Arkansas near the 15th of the month resulted in flood stages at Calico Rock and Batesville, Ark., on the upper White River.

Red River Basin.—Damaging floods occurred in the Washita River, particularly in the vicinity of Pauls Valley, Okla., late in the month. The only gaging stations maintained by the Bureau, which showed stages above flood stage were Ringo Crossing, Tex., on the Sulphur

River, where a stage of about 25.5 feet was reached on November 1, and at Arthur City, Tex., on the Red River, where a stage of 28.6 feet was reached on October 7.

West Gulf of Mexico drainage.—The city of Roswell, N. Mex., was still inundated on October 1, from the rise in the Rio Hondo which began there on September 28. The water receded early in October, the crest of this flood being higher than the rise which occurred the week previous, but no stage data are available at this writing.

The Pecos River rose to above flood stage in the irrigation district south of Red Bluff Dam on September 25 and remained above until October 16, a period of 22 days, as recorded on the gage at Pecos, Tex. The crest was reached on September 30, but the river receded very slowly after that date. Very little precipitation occurred during this period after September 29, except for moderate rains on October 3. The heavy flow in the river was maintained by the steady spilling of water over Red Bluff Dam, caused by overtaxed reservoirs in southeastern New Mexico.

The reservoirs were still full when moderate to heavy rains fell in southeastern New Mexico on October 22, 23, and 24, and conditions similar to those mentioned above developed. This time the Pecos River reached flood stage at Pecos, Tex., and remained above that stage until after the end of the month.

During the time of the highest stage of the first flood, it was estimated that 12,000 acres of farm land were under water in Reeves, Ward, and Loving Counties. The principal losses occurred during the first flood; the second one was characterized mostly by continued inconvenience.

No flooding occurred in the Rio Grande except in the lower portion. There the river exceeded flood stage slightly at Mercedes and Brownsville, Tex., from October 20 to 29.

Gulf of California drainage.—The following report is submitted by Official in Charge, Phoenix, Ariz., relative to a flood in the upper Gila River above Coolidge Dam on September 29–30:

FLOOD IN UPPER GILA RIVER, SEPTEMBER 1941

At 3 p. m., September 28, Kelvin, Ariz., reported a rainfall of 1.49 inches and a river stage of 6.6 feet, and river apparently still rising, indicating that a considerable amount of rain had fallen on parts of the upper Gila River Basin. At 5 p. m., the observer at Safford, Ariz., reported a small cloudburst (about one inch in an hour during the midafternoon) and that the river was running at the rate of approximately 10,000 second-feet at that time. Later a rainfall of 1.04 inches was telegraphed from Benson, Ariz. None of these reports indicated exceedingly heavy rains over the Gila watershed but did show that there had been a rather unusual development over southern Arizona.

During the afternoon of September 27, a peculiar cloud development began to take place and was of such a nature as to indicate the possibility of an inland movement over southern Arizona of some tropical disturbance, possibly from the Gulf of Lower California. Air of a very unstable nature began to move in rather rapidly; the instability being determined by frequent light rain of a type that is not ordinarily observed in this area. In the front of this development, for instance, it was noted that a fine rain appeared to be falling out of a practically clear sky at one time.

It was not until the morning of September 29, however, that there was any indication of the real intensity of the storm over the upper Gila Basin, and particularly in western New Mexico. Rodeo reported 3.21 inches for the 24-hour period ending at 5:30 a. m. and Mogollon, N. Mex., reported 2.86 inches. While there are times when these two reports might not reasonably indicate a general rain, the fact that the development was observed over southern Arizona prior to the rains gave some justification for assuming the general nature of this storm on the Gila Basin.

It is still not known exactly at what time the peak of the disastrous flood reached Duncan, but it seems to have been about 5 p. m. The town of Duncan was evacuated by about 3 p. m., according to all reports, and from reports no loss of life occurred.

The peak of this flow on the Gila reached Safford early in the morning of September 30, with a flow of something near 40,000

second-feet. This caused deep water over a considerable acreage of farmland and a small inhabited area, but the inhabitants were moved prior to the rise.

The losses, principally crops and real property, were as follows: Greenlee County (Duncan area):

Loss of buildings and farm land..... \$200, 000
Loss of crops..... 84, 500

Total..... \$284, 500

Graham County (Safford area): Loss of farm land and crops..... \$200, 000

Total..... 200, 000

Damage to highways, railroads, mines mostly in Greenlee County; total..... 15, 500

Grand total of all losses..... 500, 000

TABLE 1.—Flood stages in Kansas and Neosho River Basins, April to October, inclusive, 1941

River and Station	Flood stage	Highest stage reached in month of—						Previous highest of record	
		April	June	July	August	September	October	Stage	Year
Solomon River: Beloit, Kans.....	18		35.9			28.9	26.3	34.5	1935
Saline River: Tescott, Kans.....	25		29.2			27.4	25.7		
Smoky Hill River:									
Ellsworth, Kans.....	20					21.35		27.2	1938
Lindsborg, Kans.....	21		24.5		21.1	28.3	32.4	32.5	1938
Salina, Kans.....	20		20.9			22.7	24.25	24.6	1903
Enterprise, Kans.....	26		27.4			26.85	30.1	29.1	1935
Republican River:									
Concordia, Kans.....	8		11.8	8.0		8.2		17.0	1935
Clay Center, Kans.....	15		20.9			15.3		27.75	1935
Little Blue River: Hanover, Kans.....	14		25.0			18.5	15.5		
Big Blue River:									
Beatrice, Nebr.....	16		22.15			26.3		26.0	1911
Barnston, Nebr.....	20		39.5			28.6		34.0	1908
Randolph, Kans.....	22		30.8			24.1	28.0	31.7	1903
Kansas River:									
Ogden, Kans.....	18		20.7				20.7	28.5	1903
Wamego, Kans.....	17		21.9				18.4	23.8	1935
Topeka, Kans.....	21		25.8				24.6	28.0	1908
Le Compton, Kans.....	16		21.0				21.6	29.5	1903
Cottonwood River: Emporia, Kans.....	20		24.55		21.2	25.4	25.0	27.0	1928
Neosho River:									
Neosho Rapids, Kans.....	22		25.8		24.7	23.7	28.1	28.0	1932
LeRoy, Kans.....	23		28.5		24.8	23.9	26.5	29.6	1926
Chanute, Kans.....	20		26.2			26.0	27.2	28.3	1928
Oswego, Kans.....	17	22.3	21.9		17.0	23.0	25.0	25.4	1927
Fort Gibson, Okla.....	22	33.5	27.25				35.5	35.0	1908

FLOOD-STAGE REPORT, OCTOBER 1941

[All dates in October unless otherwise specified]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI SYSTEM					
Upper Mississippi Basin					
	Feet			Feet	
Wisconsin: Knowlton, Wis.....	12	8	8	12.8	8
		28	28	12.1	28
Rock: Moline, Ill.....	10	8	13	10.3	11
		23	29	10.6	25-26
Des Moines: Eddyville, Iowa.....	15	9	10	15.8	9
Illinois:					
Morris, Ill.....	13	7	8	13.7	8
Peru, Ill.....	17	7	11	18.5	8
		10	21	15.5	15
Havana, Ill.....	14	23	23	14.0	23
Beardstown, Ill.....	14	11	25	15.7	16
Mississippi:					
Quincy, Ill.....	14	11	11	14.0	11
		10	13	14.1	11
Hannibal, Mo.....	13	14	15	13.1	15
		25	28	12.2	26
		2	5	12.9	4
				12.5	12
Louisiana, Mo.....	12	(1)	(1)	12.3	22
				12.0	28
Grafton, Ill.....	18	6	8	18.3	7

See footnotes at end of table.